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THE BONES OF THE REPTILIAN LOWER JAW.

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As is well known, the lower jaw in the Reptilia consists of a number of bones to which, eighty years ago, Cuvier gave names, repeating the descriptions with slight alterations in the second edition of his work on fossil bones (1836). He described the elements in the jaw of crocodiles, tortoises, lizards, and snakes, in the order named. Since his day different anatomists have altered these names for various reasons or have applied them to different bones from those to which they were originally given. It has recently become necessary, in connection with some investigations, to revise the nomenclature of these elements, the results of which are given below. Williston has recently pointed out the necessity of some changes.

Cuvier recognized, at most, six bones to which he gave the names articulaire, surangulaire, angulaire, complementaire or coronoidien,[1] operculaire, and dentaire. These were given English forms by Owen, who changed the names of two. The operculaire he renamed the splenial so as to avoid confusion with

[1] He refers to an earlier work by Adrien Camper (*Ann. Mus. Nat. Hist., Paris*, xix, 1812) for a previous use of the term coronoidien, but Camper merely refers to the parts as the *apophyses coronoides*.

the operculum of fishes, while for the complementaire he adopted the alternative coronoid because of its resemblance to the earlier named coronoid process of the mammalian jaw. Other names have been changed by other authors.[1] Thus Wagner calls the articulare the *pars angularis*, the dentary the *pars alveolaris*, the angulare the *p. complementaris posterior*, the splenial the *p. comp. anterior*, and the surangular the *p. comp. exterior*, while Brühl calls the splenial the marginale; the surangular and the coronoid, the ecto- and endo-complementare. Baur (*Anat. Anz.*, xi, 1896) has attempted to homologize these bones in different reptiles, but it would seem that he has fallen into one or two errors, by taking the turtle rather than the crocodile or the lizard as his basis. As will be seen below there is practical unison in the use of terms by Cuvier in both crocodile and lizard while the turtle exhibits some differences, and again, to use the turtle as the basis would introduce no little confusion into the literature. So I have adopted the lizard as the basis of my work.

Practically all authors are agreed upon two of the elements, the dentary and the articulare, the first forming the anterior bone of the lower jaw, the latter being developed by ossification in the posterior part of Meckel's cartilage and forming a bone by which the lower jaw is articulated with the quadrate.

In an embryo of the lizard Sceloporus in which the centers of ossification have appeared, reconstruction from serial sections shows the following elements (Fig. 1). Meckel's cartilage (*m*) is a long, slender, slightly curved cylindrical rod, the cartilages of the two sides being continuous at the symphysis of the jaw. Just in front of the articulation with the quadrate, a strong dorsal process marks the anterior boundary of the articular facet (*a*), the cartilage extending a short distance behind this point.

The most posterior ossification is a long and slender bone (*da*) which extends backwards nearly to the posterior end of the meckelian. Behind, it lies on the lower inner surface of the cartilage, but farther forward it rises on the inner surface.

[1] No attempt has been made to find all the terms employed, or to trace each to its earliest use.

Later this element fuses with the bone ossifying in the posterior end of the meckelian, thus forming a part of the articulare, which, as is well known, consists of both cartilage and dermal constituents in the Lacertilia. For this dermal element, which in some reptiles is distinct throughout life, I have adopted the term dermarticulare.[1] Its characteristics are its position on the posterior inner side of Meckel's cartilage, its inferior margin being overlapped by the angulare and its anterior end, which lies ventral to the coronoid, by the splenial element next to be described.

The angulare (*an*) lies on the ventral surface of Meckel's cartilage, its posterior end reaching to about the middle of the dermarticulare, the lower margin of which it overlaps. The splenial (*s*) lies on the inner surface of the meckelian, its posterior end overlapping the anterior end of the dermarticulare. The coronoid (*c*), which lies on the inner side of the jaw dorsal to the splenial and the anterior end of the dermarticulare, needs little description.

On the outer side of the jaw are the dentary and the surangular bones. The dentary (*d*) occupies the anterior two thirds of the jaw, bending below the meckelian so as to be visible beneath it from the inner side, while above, it makes a broad in-curved and down-curved plate, the future alveolar surface. The surangular (*sa*) lies in the posterior third of the jaw, extending backwards behind the articulation but not quite to the posterior end of the meckelian, while below it hardly reaches the ventral border. Its upper margin arches in a broad curve above the meckelian from which it is separated by a large space.

The changes involved in the future development are extensions of all the bones so that the meckelian is covered on both inner and outer surfaces and in the coössification of articulare and dermarticulare to a single element (Figs. 2, 2a). It will be seen that these parts agree in names and positions with those described by Cuvier. The only difference between his account and that given here is the recognition of the dermarticulare as a

[1] This term has been used in the ganoids by van Wijhe. In some instances the element he has so called is clearly homologous with the dermarticulare of the reptiles but in others (Amia) it is a different form.

distinct element, the existence of which has been noted, although no name has been given it, by later writers. The problem is to homologize these elements with those found in the lower jaw of other reptiles, in some of which Baur believed that he had discovered a distinct bone which he has called the presplenial.

In the mosasaurs (Fig. 3) the matter is simple. Here dermarticular (*da*) and articular (*a*) have united into a single bone, the anterior splint of which occupies exactly the position,—below the jaw behind, rising to its inner surface in front,—that the dermarticulare does in the Sceloporus embryo. The splenial (*s*) is greatly enlarged and extends far forward on the inner surface. The other bones call for no comment, except that the surangular (*s. an*) bends inwards over the meckelian in the way described for the lizard.

Baur begins his account with a description of the turtle Emydura (Fig. 4) in which he recognizes his presplenial, but I am compelled to think that here he has fallen into error. On the inner side of the articular (*a*) is a long splint-like bone which passes forward and upward on the inner side of the jaw (*da*). This Baur interprets as the angular. In its position it clearly corresponds to the dermarticulare which has failed to fuse with the articulare proper. Below this is a bone as evidently the angulare (*an*) but which Baur is compelled to call the splenial. Hence, according to him, the true splenial (*s*) which occupies the same position as in the lizard, is an additional element, the presplenial. Baur's mistake[1] thus had its foundation in his identification of the dermarticulare as the angulare although he expressly recognizes the fact that in the Lacertilia the articulare is composed of chondrogenous and dermal elements.

In the ordinary turtles, of which the snapping turtle (Chelydra) may be taken as an example (Fig. 5), the splenial is lacking, the angulare (*an*) extends back to near the posterior end of the jaw, while the dermarticulare (*da*) forms a very large plate on the inner surface, reaching forward to just beneath the coronoid process (*c*).

Baur has also described and figured the jaw in Sphenodon

[1] Baur merely repeats the wrong identification of Cuvier.

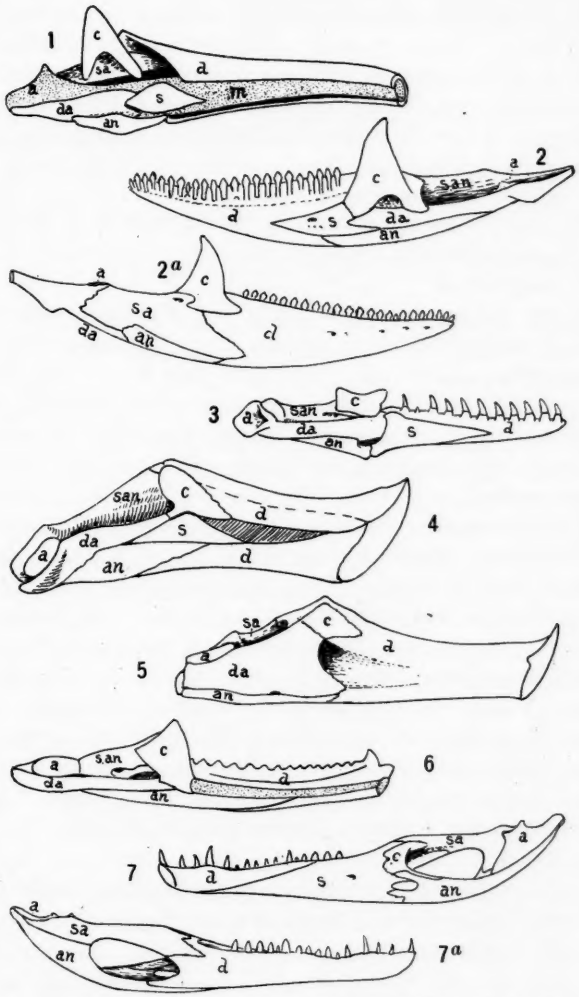

FIG. 1.— Reconstruction of elements in the jaw of an embryo Sceloporus, cartilage dotted.
FIGS. 2, 2a.— Inner and outer surfaces of jaw of *Iguana tuberculata*, after Blanchard.
FIG. 3.— Jaw of *Platecarpus coryphæus*, after Williston.
FIG. 4.— Jaw of Emydura, after Baur.
FIG. 5.— Jaw of *Chelydra serpentina*.
FIG. 6.— Jaw of Sphenodon, after Baur.
FIGS. 7, 7a.— Jaw of *Alligator lucius*, inner and outer surfaces.
a, Articulare; *an*, Angulare; *c*, Coronoid; *d*, Dentary; *da*, Dermarticulare; *m*, Meckel's cartilage; *s*, Splenial; *sa. s. an*, Surangulare.

(Fig. 6), and his identifications are adopted by Howes and Swinnerton. Yet it seems probable that here again the dermarticulare (*da*) has been termed the angulare and the angulare (*an*) the splenial. Judging by Günther's figures, which do not agree with that of Baur, it is possible that the angulare is an angulosplenial as he suggests, but the observations of Howes and Swinnerton show no separate elements. The articulare cannot be a compound structure like that in the Lacertilia, for, in the development no dermarticulare, other than that interpreted as such here, occurs.

In the case of the alligator (Fig. 7) I feel less certain. As is well known, besides the articulare (*a*), three bones form the inner surface of the jaw, a bit of the dentary (*d*) being visible near the tip. There can be no question about the coronary (*c*) while the large plate extending forward from the coronoid (*s*) is as clearly the splenial, if the conclusions regarding the other forms studied be correct. The remaining element (*an*) is the more problematical. Baur calls it the splenial and thinks that the angulare is fused with the articulare. It is clearly not the splenial, but it exhibits characteristics of both angulare and dermarticulare, being like the dermarticulare in its articulation with the coronoid, but like the angulare in the rest of its extent. There is no separate bone on the inner side of the articulare and there is a large gap in front of the articulare, extending to the coronoid, which in all other forms is occupied by the dermarticulare. Hence until a study of the development shows that this conclusion is untenable I prefer to call it the angulare and to assume that the dermarticulare has failed to develop. It is the angulare of Cuvier.

These comparisons need to be continued into the Ichthyopsida and especially into the Stegocephala and the ganoids where considerable confusion exists.

CONTRIBUTIONS FROM THE ZOÖLOGICAL LABORATORY OF THE MUSEUM OF COMPARATIVE ZOÖLOGY AT HARVARD COLLEGE. E. L. MARK, DIRECTOR.— No. 160.

NATURAL AND ARTIFICIAL PARTHENOGENESIS.[1]

ALEXANDER PETRUNKÉVITCH.

WITH the discovery by Oscar Hertwig, in 1875, of the essential nature of fertilization as the union of the nuclei of the two parental germ-cells, the line of research in the branches of biology dealing with reproduction became more clearly defined. While on the one hand this discovery put an end to all guess-work, on the other hand it threw light on the part taken in development and heredity by both egg and sperm. To this was added later the knowledge of the behavior of the centrosomes in fertilization, the whole bringing us nearer to an understanding of the otherwise incomprehensible phylogenetic separation of living beings into two sexes, impelled by the necessity of amphimyxis. Again, the theory of the individuality of the chromosomes and the study of the process of reproduction in maturation afforded us an insight, incomplete though it be, into those forms of reproduction which are not accompanied by fertilization. New questions were gradually evolved, but since they had their source in facts recognized by everyone, they were so precise, that when, five years ago, I entered upon the study of parthenogenesis in the honey-bee, I had before me a very definite problem.

All this I purposely mention here. By the time I had published the first part of my research and had gone on in the study of natural and artificial parthenogenesis, there began to appear objections not only to the results of my own work, but even to statements hitherto undisputed, as well as to the most sober interpretations of facts. These objections were raised

[1] Read before Section F — Zoölogy — of the A. A. A. S. at the 54th annual meeting in Philadelphia, 1904.

not only by people unacquainted with the facts won by science and with the methods of scientific research, as bee-keepers for instance, but also by men of very considerable scientific education, especially physiologists. It seems to me therefore seasonable to review briefly these objections, in order to determine what, if anything, has been gained through this controversy, so that we may know how the question of parthenogenesis now stands.

Our knowledge of fertilization and parthenogenesis, acquired in the study of many different animals, may be recapitulated in the following words:

1. Both the egg ready for fertilization and the mature sperm show a reduction in the number of chromosomes of their nuclei to one half of that found in somatic cells.

2. No matter how many spermatozoa succeed in entering the egg, the nucleus of only one of them, under normal conditions, fuses with the egg-nucleus, thus restoring the chromosomes to their original number. All other spermatozoa are absorbed.

3. The centrosome of the egg disappears after the second polar cell is formed, its functions being assumed by the centrosome of the spermatozoön.

4. In most parthenogenetic eggs no reduction of chromosomes takes place — only one polar cell being formed — and the egg-centrosome remains active.

Now, all of the objections alluded to above are directed against one or more of these four propositions. As, however, it is in these propositions that our present understanding of parthenogenesis is epitomized it is of urgent importance to discover how much of truth these objections contain.

First of all I shall consider the objections brought forward by the physiologist Bethe and the zoölogist Bresslau. Both claim to find the essence of fertilization not in the union of the sperm-nucleus with the egg-nucleus, but in the entrance of spermatozoa into the egg. Bethe (:04) says explicitly: "I consider an egg fertilized when a spermatozoön has entered it. What becomes of this spermatozoön later on is another question." He says, further, that not alone the chromosomes of the nucleus enter the egg, but also other substances, of whose fate we know

nothing, and that we keep in sight a part, only, of the whole phenomenon when we speak of fertilization as the union of nuclei. Bresslau (:04) supports nearly the same view, and distinguishes between "Besamung," or the entrance of spermatozoa into the egg, and "Befruchtung" or fertilization in the sense of Hertwig, Weismann, and others, *i. e.*, the union of the nuclei.

In one respect Bethe and Bresslau are right, that is, as to the necessity of distinguishing between these two phenomena; but it remains to decide which of the two phenomena exerts the greater influence upon the development of the egg and may therefore be considered the one essential to fertilization. This question seems to me easy of solution in the light of recent experiments and observations. There can exist no doubt as to the importance of the union between sperm- and egg-nuclei. The normal number of chromosomes is indispensable to normal development. The paternal hereditary characters are transmitted to the descendant by the chromosomes of the sperm-nucleus. Even if the protoplasm of the spermatozoön, in those cases where it succeeds in entering the egg (for it is frequently cut off by the suddenly formed yolk-membrane), should possess the power of transmitting by heredity certain paternal qualities, yet, in the presence of the egg-centrosomes, it loses that power. Nor can there be doubt as to the importance of the part taken by the sperm-centrosome. It gives the stimulus to development and controls the successive divisions. Without it there can be no development; when hindered in the normal performance of its functions, abnormal development results.

We now turn our attention to the phenomenon of the entrance of spermatozoa into the egg. Does it make any difference in the development of an egg whether one or several spermatozoa enter it? No, for the nucleus of only one spermatozoön is destined to unite with that of the egg. In those cases where polyspermy exists normally, all spermatozoa with the exception of one are gradually absorbed by the egg-protoplasm, and the resulting development is the same whether the spermatozoa are many or few; but when, as sometimes happens, they are not absorbed by the egg-protoplasm, their centrosomes form independent centers for cell-division, thus interfering with the nor-

mal development of the egg, and sometimes even proving fatal. Abnormal development also follows where the egg-nucleus unites with more than one sperm-nucleus.

Thus the entrance of a spermatozoön into an egg cannot be regarded as in itself the efficient stimulus to normal development. Moreover, it is possible by etherizing an egg, to prevent the union of the sperm-nucleus with the egg-nucleus. By this means one half of the egg, that containing the egg-nucleus, develops parthenogenetically, while the other, containing the sperm-nucleus, develops merogenetically. Knowing all this, one must realize that the simple fact that a spermatozoön has entered an egg is relatively unimportant, though it is of course a necessary step in fertilization, rendering possible the union of the two pronuclei.

I consider it therefore perfectly correct to hold to the old definition of fertilization and to call an egg fertilized only when the union of the nuclei is accomplished. This definition does not take into account the behavior of the centrosomes, and rightly, since these constitute only the stimulus and the controlling apparatus of division and are not as important as the chromosomes, *i. e.*, whether the division is accomplished through the influence of the egg-centrosome, or that of the sperm-centrosome, does not change the outcome of the union of the pronuclei.

Applying the same standard to a definition of parthenogenesis, we should expect to say that the latter represents development without fertilization; yet we shall see that such a definition is too broad and that in order to avoid misunderstandings it is necessary to restrict it in certain points.

Development without fertilization takes place normally in many animals of different groups. Leaving out of consideration reproduction by the division of the whole animal, we find these three kinds of propagation: parthenogenesis, pædogenesis, and budding. Under budding we understand development through successive, regular mitotic cell-divisions, proceeding from one or several cells. Parthenogenesis is always development of an unfertilized egg and is introduced by a maturation process, while the nature of pædogenesis is not yet known. The facts that pædogenesis occurs in only a few animals and

that these animals are very rare, make its study exceedingly difficult. We know no more now than was contained in the work of Metschnikoff on Cecidomyia, the account of which appeared in 1865, when the maturation divisions of the egg were still unknown. Should further research show that pædogenesis is also introduced by a process of maturation in the egg, it must then be regarded as a case of larval parthenogenesis. If, on the contrary, the maturation process is wanting in pædogenetic development, it would be more reasonable to place pædogenesis in the same group with budding. In any event it is a problem by itself.

The process of maturation in the egg is without doubt equally indispensable for parthenogenetic development and for that resulting from fertilization; yet there is a great difference between the two, the importance of which was at once recognized by Weismann, its discoverer, many years ago. All eggs requiring for their development fertilization, undergo a double maturation division. This results in the reduction in the number of chromosomes by one half. On the other hand, in the majority of parthenogenetic eggs — the single exception being that of certain insects — there takes place but one maturation division, and in consequence, there is no reduction in the number of chromosomes. In this way the opportunities for variation are much restricted. The exception to this rule is found in those insects in which only one sex develops parthenogenetically, and in the male individuals in those cases where both sexes develop parthenogenetically. In such cases two maturation divisions invariably take place with a corresponding reduction in the number of chromosomes. The insects which on account of the possession of this peculiarity have been much studied lately, are the ants and the bees. In these Hymenoptera it is only the males that develop parthenogenetically. I have every reason to re-affirm this, notwithstanding the recent objection raised against it.

After what I have said about fertilization it is clear that microscopic study, and that only, is able to show without error whether an egg is fertilized or not. The development of an aster around the centrosome of the spermatozoön after the lat-

ter has entered the egg, facilitates the finding of the sperm-nucleus, which keeps its place close behind the migrating centrosome. Were it not for the objections which have been raised by men like Pflüger and Bethe, I should scarcely need to mention that this sperm-aster develops in the same way throughout the entire animal kingdom, that in polyspermic bee-eggs similar asters appear in numbers equalling those of the spermatozoa which enter the egg, and that also in the so-called drone-egg an aster would surely develop, should a spermatozoön enter it. The experiments made upon the eggs of bees, consisting in transporting them from one kind of comb-cell into another, in an attempt to change their sex, have proved to be failures. Should similar experiments, however, some day meet with success, it would only show that it may be possible artificially to change sex.[1] The objection that in drone-eggs the aster might not develop because of the influence of the saliva of the workers which take charge of the eggs as soon as they have been laid, and that in consequence a spermatozoön, though present, might easily be overlooked, does not bear critical investigation. Experiments and microscopic preparations alike showed that the saliva of the workers exerts no such influence. For when fertilized eggs are treated with the same saliva, the aster none the less develops. Or would the opponents of parthenogenesis — who believe that a queen can by no reflex be impelled to fertilize or to inhibit the fertilization of her eggs as she lays them in worker-cells or in drone-cells — be bold enough to affirm that the workers treat the eggs with two different kinds of saliva, corresponding to the comb-cells in which these eggs are laid? Yet this is what the opponents of parthenogenesis claim. How

[1] Experiments in attempting to change sex artificially have been made by vom Rath, by v. Buttel-Reepen, by myself, and by others with negative results. Experiments with apparently positive results have been made and often described by Dickel, a German bee-keeper. I desire here earnestly to warn against the attempt to use in any way whatsoever the experiments of Dickel without first verifying them, as he has on several occasions in his scientific work practiced deliberate fraud in an effort to support his theory, for which delinquency he has frequently been called to account by v. Buttel-Reepen and myself. The history of the falsely labelled bottles containing bee-eggs, together with my exposure of this deliberate trick, made clear the absence of spermatozoa in drone-eggs and thus demonstrated the efficiency of microscopic study.

wonderfully complicated that reflex would have to be which could stimulate to action at a given time only one of three pairs of glands which possess a single duct common to them all!

There are still other difficulties in the way of these objections. The union of the nuclei, not the presence of an aster, is the essential of fertilization. Now, this union of the nuclei may readily be observed, whether the aster lies in the same microscopic section with the nucleus or not, and even when it does not appear at all. Since there is no union of nuclei in drone-eggs, they are not fertilized. As this is the only reasonable conclusion, it sounds strange to hear Pflüger (:03) say that to claim parthenogenesis for the bee, is to adopt a false and insufficiently supported hypothesis, and that the queen-bee is probably a hermaphrodite in which the male sexual glands have not yet been discovered. Still stranger is the contention of Bachmetjew (:03), who says that the right wing of the drone and the left wing of the worker develop parthenogenetically, while the left wing of the drone and the right wing of the worker are the result of fertilization, on the ground that the number of hooks on their wings is subject to variation, displaying two different maxima of frequency. If the theory of partial parthenogenesis can find any support in facts, it is more likely to be applicable to those cases of bee-monsters which exhibit a marvelous mosaic of male and female characters.

If, however, more than one form of parthenogenetic development can with certainty be recognized, should not microscopical research be able to throw light upon the origin of these forms? The answer to this question may be looked for in the behavior of centrosome and chromosomes. There can be no doubt that in parthenogenetic eggs the egg-centrosome remains active, and in *Artemia salina*, at least, we can easily see that it moves alone toward the center of the egg to await there the nucleus, which after the single maturation division, is destined to become the first cleavage nucleus. Thus does the egg-centrosome in parthenogenetic eggs maintain its individuality through all cell generations. In the fertilized egg of bees the centrosome of the spermatozoön becomes the active centrosome and as such passes in turn into the spermatozoön of the next generation. We may

therefore say that in all cases in which either both sexes, or even one sex, invariably develop from fertilized eggs, every centrosome (even that of the egg, which is destined to disappear) is a descendant of a sperm-centrosome — a *male* centrosome, if I may so call it. There is apparently a difference between this and pure parthenogenesis, where every centrosome is a descendant of the egg-centrosome and could be called a *female* centrosome. Does such a difference in reality exist? If we believe with Wedekind (:02) that parthenogenesis is an original, primary mode of development, we must admit that it does. But this would mean that animals which are closely related to each other differ in their phylogenetic origin. Is it not simpler to admit that even in pure parthenogenesis the ostensibly female centrosomes are descendants of a remote ancestral male centrosome? It seems, indeed, as though in animals where fertilization occurs only as a rare exception the males had gradually disappeared yielding to hermaphroditism and parthenogenesis, as Maupas (:00) has so beautifully shown for certain nematodes.

Still more important biological problems are connected with the behavior of the *chromosomes* in parthenogenesis. In pure parthenogenesis only one maturation division takes place and the number of chromosomes remains normal; the individuality of the chromosomes is preserved and thus the questions of variation and hereditary transmission are greatly simplified. Not so in the case of that form of parthenogenesis in which the number of chromosomes is reduced. I have elsewhere (Petrunkewitsch, :02) pointed out that the great difficulties here encountered by the theory of Weismann — which maintains not an essential, but a *qualitative* difference only between the chromosomes — grow out of the cessation of hereditary transmissible variability. There seem to be fewer difficulties in the way of the theory of Sutton and Boveri,— who affirm that the chromosomes are *essentially* different,— since I have shown — and still maintain after a careful re-examination of my sections, in opposition to the objections of Doncaster (:04) — that the number of chromosomes in the first cleavage nucleus of the drone-egg again becomes normal, probably through longitudinal splitting without a corresponding division of the cytoplasm. I thought to find a support for

Weismann's theory in my observation that in parthenogenetic eggs the polar cells, after a copulation similar to that of the pronuclei, give origin through successive divisions to many cells which may be easily traced as far as the gastrulation stage of the embryo. My attempt to trace them still farther and to show that the male sexual glands in bees develop from these cells, has met with much criticism and requires confirmation. Doncaster, however, was able to prove in Nematus the accuracy of my observations as far as the beginning of the blastoderm stage. Although I am still, and until convinced of error shall remain, an adherent of Weismann's theory, I admit that the Sutton-Boveri theory would be strengthened, if it could be shown with certainty that I was at fault in my observations, and that the sexual glands of the drones develop not from polar cells but from the pronucleus. Future research will reveal the truth, but one thing is already certain: in all parthenogenetic eggs hitherto studied, with possibly the one exception of Nematus (according to Doncaster), the number of chromosomes in the first cleavage nucleus becomes in some way equal to that in the somatic cells. This is not limited to animals, but applies equally well to plants[1] and is consequently of fundamental importance. Yet it is not impossible that in Nematus there is no reduction in spermatogenesis, which would lead to the same thing.

It is clear that to reach a solution in the problems connected with the two theories of which I speak, we ought not to limit our research to observation of normal parthenogenesis alone, but rather to supplement such observation by the use of experiment. Here two methods are possible, of which one is cross-breeding and inbreeding, the other, artificial parthenogenesis and merogeny. Much light could be gained by experiments in the former upon animals like the bees, since such experiments would have many advantages over similar ones made on animals developing by fertilization only. Although this method promises much, it has never yet, I regret to say, met with scientific application.

By fertilizing enucleated eggs we obtain development by mer-

[1] Compare the observations of J. B. Overton (:04) on Thalictrum purpurascens.

ogeny, which is characterized by a reduced number of chromosomes, and by the presence of the active sperm-centrosome. In stimulating unfertilized eggs by chemical or physical means to develop, we get what is called artificial parthenogenesis. As I have elsewhere (Petrunkewitsch, : 04) tried to show, this development is due not to a new formation of centrosomes,[1] but to the stimulation to new life of the egg-centrosome, which is otherwise destined to disappear. According as we apply the stimulus before or after the second maturation division, we obtain different results; if before, we get development with the normal number of chromosomes, if after, then with the reduced number. Now, it is interesting that both parthenogenetic development with the reduced number of chromosomes and merogenic development show abnormalities when compared with the development of fertilized eggs. These abnormalities increase in inverse proportion to the number of chromosomes left in the egg, an indication of which is given in the experiments of Stevens, which consisted in a dissection of the fertilized egg in the amphiaster stage into two parts containing unequal numbers of chromosomes. All this goes to show that neither merogeny nor artificial parthenogenesis with a reduced number of chromosomes can be regarded as equivalent to natural parthenogenesis. I call, therefore, these two forms, *artificial, pathological, uniparental development.* On the other hand, artificial parthenogenesis with the normal number of chromosomes leads to apparently normal development. I therefore call it *artificial, true parthenogenesis.*

If we could cause an egg to develop by applying a stimulus before the first maturation division, the gap between parthenogenesis and budding would be filled. Again, if we could bring about artificial parthenogenetic development through several successive generations by stimulating the eggs at the three different moments of their maturation, we might obtain valuable

[1] If there are such *de novo* formations of centrosomes, as seems to be again emphasized by the research of Yatsu (:04), it is nevertheless probable that in experiments with artificial parthenogenesis, the divisions are due to the egg-centrosome. This being present in every egg, is stimulated to new life, and counteracts possible teratological action on the part of the artificial centrosomes.

results connected with the questions of individuality of chromosomes, determination of sex and variation. These are the problems to which my own study of parthenogenesis has naturally led me and to which I am now seeking solutions in experiments. In this way parthenogenesis, an important problem in itself, becomes at the same time a method for the study of other and greater problems.

BIBLIOGRAPHY.

BACHMETJEW, P.
:**03**. Ein Versuch, die Frage über die Parthenogenese der Drohnen mittels der analytisch-statistischen Methode zu lösen. Allg. Zeit. f. Entomol., Bd. 8, no. 2–3, pp. 37–44.

BETHE, A.
:**04**. Entgegnung auf den Aufsatz von v. Buttel-Reepen in Nr. 4 dieser Zeitschrift. Bienenwirtschaftliches Centralblatt, 1904, no. 11, 2 pp.

BRESSLAU, E.
:**04**. See 'Diskussion.' Verhandl. Deutsch. Zool. Gesellsch., 14. Jahresvers. zu Tübingen. Leipzig, 1904, pp. 66–72, 73–77 *passim*.

DONCASTER, L.
:**04**. On the Early Development of the Unfertilized Egg in the Sawfly, Nematus ribesii. Proceed. Cambridge Philos. Soc., vol. 12, part 6, pp. 474–476.

MAUPAS, E.
:**00**. Mode et formes de reproduction des nématodes. Arch. zool. exp. gén., sér. 13, tom. 8, no. 3, pp. 463–624, pl. 16–26.

OVERTON, J. B.
:**04**. Ueber Parthenogenesis bei Thalictrum purpurascens. Berichte Deutsch. Bot. Gesellsch., Bd. 22, Heft 5, pp. 274–283, Taf. 15.

PETRUNKEWITSCH, A.
:**02**. Das Schicksal der Richtungskörper im Drohneni. Ein Beitrag zur Kenntniss der natürlichen Parthenogenese. Zool. Jahrb., Abth. f. Anat. u. Ontog., Bd. 17, Heft 3, pp. 481–516, Taf. 11–13.

PETRUNKEWITSCH, A.
:**04**. Künstliche Parthenogenese. Zool. Jahrb., Suppl. vii, Festschrift Weismann, pp. 77–138, Taf. 8–10. *Also separate*, 62 pp. 3 Taf., 1904.

PFLÜGER, E. F. W.

:**03**. Ueber die jungfräuliche Zeugung der Bienen. Arch. f. d. ges. Physiol., Bd. 99, Heft 3–4, pp. 243–244.

Also in Münchener Bienenzeitung, no. 20, 1903.

WEDEKIND, W.

:**02**. Die Parthenogenese und das Sexualgesetz. Verhandl. 5. Internat. Zool. Congr. zu Berlin, pp. 403–409.

YATSU, N.

:**04**. Aster Formation in Enucleated Egg-fragments of Cerebratulus. Science, vol. 20, no. 521, pp. 889–890.

THE ANGLE OF DEVIATION FROM THE NORMAL VERTICAL POSITION AT WHICH STEMS SHOW THE STRONGEST GEOTROPIC RESPONSE.[1]

JULIA ANNA HAYNES.

INTRODUCTION.

SACHS ('82) seems to have been the earliest botanist to pay particular attention to the relation between the angle of deviation in orthotropic plant organs and the strength of the geotropic response. He found, by experiment, that main roots of beans and oak seedlings inclined 8 or 10 degrees from the vertical, slowly or never came into the normal position, while if placed at an angle of 80 or 90 degrees, the growing parts curved 80 or 90 degrees in a few hours. In his "Lectures on the Physiology of Plants," Sachs ('87) also speaks of using in these experiments, thick, rigid, long internodes of such flower-stalks as attain considerable heights in short periods. The results led him to the conclusion that zones of similar developmental stages make various curvatures during the same time if they form various angles with the vertical. That is, the curvature is stronger, the more nearly the angle of deviation approaches to a right angle. If, therefore, this angle of deviation is a right angle, the maximum of growth-difference between the upper and lower sides is attained (Sachs, '74).

Miss Bateson and Francis Darwin ('88) used decapitated flower-stalks of *Plantago lanceolata* and *Brassica oleracea* and found, after numerous experiments, that in both Plantago and Brassica, the greatest curvature was made by the stems placed horizontally, less curvature by those inclined more than 90

[1] Contributions from the Botanical Laboratory of the University of Michigan. No. 85.

degrees, and least curvature in the stalks inclined less than 90 degrees.

Czapek ('95) took up the same line of experimentation as Bateson and Darwin, considering also the point which the other experimenters seem to have neglected, *i. e.*, the latent period of curvature in the various angles of deviation. His purpose was to determine at what angle of deviation it is possible to get the largest angle of geotropic after-effect, "the maximum reaction," for equally long induction periods. To eliminate specific differences, a variety of plants was used: Lupinus, *Faba vulgaris* (*Vicia faba*), Phaseolus, Pisum, and Zea seedling-roots, hypocotyls of Helianthus, and matured internodes of Secale. The general result of Czapek's experiments is given in the statement that the extent of the angle of after-effect curvature increases steadily from the normal vertical position, reaching a maximum at about 45 degrees above the horizontal or 135 degrees from the normal, in the case of roots; 45 degrees below the horizontal, or 135 degrees from the normal, in the case of stems; then falls from that point to the inversely vertical position, 180 degrees from the normal. The horizontal position is not, therefore, according to Czapek, the one in which the maximum reaction takes place.

In spite of his attempts in numerous experiments, even artificially lengthened for the purpose of enlarging small time-differences, Czapek could detect no noticeable difference, as to time of beginning curvature, in stems inclined from 20 degrees to 150 degrees, but in those inclined less than 20 degrees and in those whose angles of deviation were between the optimum for geotropic response and the inverted position, 180 degrees deviation, found a very considerable delay in the beginning of response.

Stone (: 00) experimented with dynamometers, measuring the after-effects of geotropic stimulation and found that in grass-nodes and in the roots of *Vicia faba*, all experiments gave similar results, indicating the horizontal position as that of greatest geotropic excitability. He further found the relationship between nodes at oblique angles and those horizontal to be proportional to the cosines of their angles.

Jost (:02), after making various experiments, agrees with Stone in doubting the validity of Czapek's results.

Just as this paper was ready to send to the publisher, there came to hand a preliminary report by Fitting (:04) in which the author states, among other results, that by a method somewhat similar to mine he has found the strongest geotropic effect when orthotropic plant members were placed in the horizontal position, that is, at 90 degrees from their position of equilibrium.

Because of this division of opinion, and since, in all cases, the experimenters had been led to favor one of the two angles of deviation, 90 degrees or 135 degrees, it seemed that other angles might be neglected and the issue drawn between these two. The present paper reports the results of a series of experiments made in the Botanical Laboratory of the University of Michigan under the direction of Professor Newcombe for the purpose of determining, in a considerable number of plants, at which of these two angles of deviation stems show the stronger geotropic response. Since the earlier work had dealt chiefly with seedling-roots and hypocotyls, the unbranched stems of actively growing young plants were selected as the material for use in most of these experiments.

Method of Alternating Stimulation.

The two general methods used we shall call the "Alternating Stimulation" and the "After-effect" methods. It will be noticed that each differs somewhat from the methods of earlier workers. In all cases, except the first few experiments with Chrysanthemum which were made in the greenhouse where the plants were illuminated on all sides, the work was carried on in a dark-room whose temperature ranged from 20° to 24° C. (18.5° C. in one case).

It is evident that an orthotropic plant stem, if equally stimulated on opposite sides, will remain straight, but if unequally stimulated on the opposite sides, will become curved, and by the direction of its curvature indicate the stronger of the two stimuli. Since it was believed that the response of stems would be greater for stimulation in one of the two positions of

deviation in question than in the other, it was proposed to incline the plants first 90 degrees from the normal vertical position, then 135 degrees from the normal, but in the opposite direction, and to alternate between these two positions giving the same length of time and number of exposures in each, until a decided curve should result.

A special frame, devised by Professor Newcombe, made it possible to experiment with a considerable number of potted plants at one time. This frame was furnished with a hinged rack for holding the pots and this was so hung or supported that by turning it from one stop to another, through an arc of 225 degrees, the plants could be set first at an angle of 90 degrees, on one side of the vertical position, then at an angle of 135 degrees on the opposite side, or *vice versa*, and could be quickly and easily turned from one position to the other with a minimum of jarring.

The stems of the young plants selected were first tied to upright sticks or wires, leaving the upper, growing portions of the axes free to curve, while the weight of the older parts of the stems was supported to prevent all sagging when they were turned out of their normal position. In the case of several seedlings in one pot, all whose hypocotyls were not vertical were cut away at the outset. The pots were then firmly wedged in the frame, care being taken to keep the growing tips upright. When all was in readiness, the frame and its rack were turned so as to bring all the stems into one of the two positions desired, and alternation was begun.

Experimentation.

Young plants of Chrysanthemum, Ageratum, Lavandula, Fuchsia, Heliotropium, and Coleus were used in these experiments; also seedlings of *Linum usitatissimum*, *Raphanus sativus*, *Brassica alba*, and *Helianthus annuus*. The process of alternation was continued from 2 to 7¾ hours according to the sensitiveness of the plants. When a noticeable curve appeared after an equal number of exposures in the two positions, the pots were set upright again and the direction of the stems was carefully noted.

The accompanying figure shows the frame turned on its side to bring the set of young Chrysanthemum plants into the upright position for observation at the close of one experiment. Plants 1, 3, and 4, numbering from the front, show typical curves. Other plants of the set gave equally good curves which do not show distinctly in this view.

During alternation experiments, the frame stands on the base

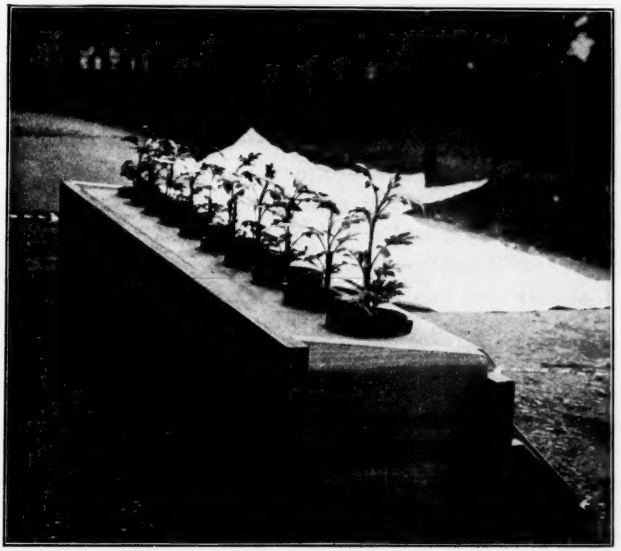

FIG. 1.— Plants in turning-frame. *a*, base; *b*, hinge-line; *c*, stop.

a and the shelf hinged at *b* hangs vertically while exposing the stems at 90 degrees from the normal position, then is turned over to stop *c* to make the exposure at 135 degrees from the vertical.

After experimenting in this way for some time, it was thought that an error might have entered through closing the experiments immediately after exposing the plants in the last position, thus allowing no time for the appearance of its resulting curvature, and, in effect, giving less exposure in one of the two positions than in the other. To remedy this, in the later

experiments the plants were allowed to stand upright for half an hour after the last exposure, before making the final observation. In no case did this modify results in favor of the deviation of 135 degrees, while with few exceptions, the plants, after this treatment, showed more pronounced curves in favor of the deviation of 90 degrees than they did at the close of stimulation. This was true whether alternation was begun from the position of 90 degrees deviation or from that of 135 degrees.

Marked differences in sensitiveness, indicated by the length of time required to produce curvature, were shown not only by plants of widely different genera but by different individuals of the same species and by the same individual at different times.

Of the 395 plants used in these experiments, 53 did not respond in the time given to the experiment, and are simply to be considered less sensitive than their fellows showing curvature. Of the 342 that did curve, 331 or 96.8 % responded better for the deviation of 90 degrees, 11 or 3.2 % only, for the deviation of 135 degrees.

Table I. Results Obtained by Alternating Stimulation.

No.	Material.	Temp.	Time Hrs. Min.	No curvature.	Curvature at Deviation of 90 degrees	135 degrees
	Young plants.					
6	Chrysanthemum		2 — 0	3	3	0
6	"	13° C	3 — 20	2	4	0
5	"	18° C	3 — 20	1	4 2 slight	0
5	"	21° C	3 — 40	0	5	0
6	"	23° C	3 — 0	0	6 1 slight	0
10	"	22° C	7 — 45	0	10	0
9	Ageratum	20° C	5 — 0	0	9	0
5	Heliotropium	22° C	4 — 0	0	5 2 very slight	0
7	Lavandula	23° C	3 — 40	0	7 1 slight	0
7	"	22° C	3 — 0	0	7	0
3	"	22° C	2 — 40	0	3 1 slight	0
10	Fuchsia	25° C	2 — 0	0	10	0
10	"	18° C	2 — 40	5[1]	5	0
9	"	20° C	3 — 40	0	9	0
9	Coleus	23° C	3 — 0	0	7	2 very slight
2	"	22° C	2 — 40	0	0	2 very slight
	Seedlings.					
8	Linum			3	5	0
150	Raphanus sativus	24° C	2 — 0	3	145	2

[1] After standing upright 30 minutes, all were curved in favor of 90 degrees deviation.

Table I.— Continued.

No.	Material.	Temp.	Time Hrs. Min.	No curvature	Curvature at Deviation of 90 degrees	135 degrees
29[1]	Raphanus sativus	22° C	4 — 0	8	18	3 apparently
22[1]	" "	21° C	6 — 30	7	14	1
31[1]	Brassica alba	22° C	4 — 0	3	28	0
25[1]	" "	21° C	6 — 30	11	14	0
21[1]	Helianthus annuus	21° C	6 — 30	7	13	1
395				53	331	11

Number showing curvature, 342.
Percent of these showing curvature for deviation of 90 degrees, 96.8.
" " " " " " " " 135 " 3.2.

After-effect Method.

By this method, orthotropic plant members are exposed to the one-sided action of gravitation by being placed out of their normal position; but before a geotropic curve has time to appear, the plant is put upon the klinostat and so revolved that the further curving effect of gravitation is neutralized during the revolution. Thus any geotropic influence induced in the plant before the plant was placed on the klinostat has opportunity to manifest itself. If, now, the gravitation effect on plants differs according to the deviation of the plant from its normal position, we may expect the size of the after-effect angle attained on the klinostat to be greatest when the previous exposure of the plant was made at the angle of optimum stimulation. In other words, this method may possibly be used to aid in the discovery of the angle of optimum stimulation.

It was believed that results obtained by exposing stems for the short period to the gravity-stimulus would be more reliable than those of Czapek who forcibly prevented all curvature of the roots and hypocotyls used while exposing them for hours to the action of gravity in each of the two positions, and thus, it would seem, making it possible for the long continuance of a weak stimulus to equal the effect of a stimulus in reality stronger.

[1] Results quoted from Professor Newcombe by permission.

Experimentation.

The plants used in these experiments were prepared as in the preceding series, then fixed on klinostats with stems radial to the horizontal axes of rotation. One half of the number used were inclined 90 degrees, the other half, 135 degrees from the vertical, and both sets were held in position for a time somewhat shorter than the previously determined latent period for geotropic curvature in the species used. The subsequent influence of gravity was then removed by rotation on the klinostats for a time at least twice as long as the period of stimulation, and finally, the pots were set upright and the amounts of curvature made by the plants of the two groups were carefully compared.

The number of individuals, as well as the number of species used in these experiments was smaller, and the results obtained were less satisfactory than in the experiments by the method of "alternating stimulation," but when any difference in after-effects could be observed, it was in agreement with the results of the alternation experiments. Ageratum, Lobelia, Chrysanthemum, and the seedlings of Linum showed greater curvature as the after-effect of stimulation at the angle of 90 degrees from the normal position than at 135 degrees.

Table II. Results by After-effect Method.

Material.	Temperature.	Latent Period.	Time of Exposure.	Time of Rotation.	Greater Curvature for Deviation of
Young plants.					
Lobelia	25.5° C	30 min.	20 min.	40 min.	90 degrees
Ageratum	22.0° C	20 "	15 "	40 "	90 "
Chrysanthemum	22.0° C	30 " +	30 "	60 "	90 "
Seedlings.					
Linum	26.5° C	25 " +	25 "	50 "	90 "

Conclusions.

In conclusion it may be said that both the method of "alternating stimulation" and the "after-effect" method as I have used them in numerous experiments involving a greater number of species than other experimenters have reported, furnish remarkably strong evidence that stems respond better to the gravity stimulus when their angle of deviation from the normal position is one of 90 degrees than when it is one of 135 degrees; and since the question seems to have been narrowed to these two angles by earlier workers, it may further be claimed that the angle of deviation from the normal vertical position at which stems show the strongest geotropic response is one of 90 degrees.

University of Michigan.

BIBLIOGRAPHY.

Bateson, A. and Darwin, F.
'88. A Method of Studying Geotropism. Annals of Bot., II, 65.
Czapek, F.
'95. Untersuchungen über Geotropismus. Jahrb. Wiss. Bot., XXVII, 283.
Fitting, H.
:04. Geotropische Untersuchungen. (Vorl. Mittheil.) Ber. Deutsch. Bot. Gesellsch., XXII, 361.
Jost, H.
:02. Die Perception der Schwerereizes in der Pflanze. Biol. Centralbl., XXII, 167.
Sachs, J.
'74. Ueber das Wachsthum der Haupt- und Nebenwurzeln. Arbeit. Bot. Inst. Würz., I, 454.
'82. Ueber orthotrope und plagiotrope Pflanzentheile. Arbeit. Bot. Inst. Würz., II, 240.
'87. Lectures on the Physiology of Plants. English translation.
Stone, G. E.
:00. Geotropic Experiments. Bot. Gazette, XXIX, 136.

NOTE ON VARIATION IN THE RAY FLOWERS OF RUDBECKIA.[1]

RAYMOND PEARL.

In a recent number of this journal (Vol. XXXVIII, pp. 427–429) Mr. F. C. Lucas has published an account of the variation in the number of ray flowers in *Rudbeckia hirta*, the common "brown-eyed Susan." Since attention has been called to the matter in this way, it seems desirable to put on record some statistics on variation in this form collected by the writer.

My material consisted of 430 heads from plants collected at random from a large patch, July 25, 1903. The locality was Farmington, N. H. The plants were growing in an open hay field, on a moderately sloping hillside. The soil was a sandy loam, and on account of the thorough drainage, the ground was decidedly dry. In the counting I was assisted by Mr. Roswell T. Pearl.

The following frequency distribution of ray flowers was obtained:

Number of ray flowers.	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Frequency.	5	11	59	37	42	49	55	121	19	11	10	2	3	1	2	1	0	0	1
Total.	430																		

The frequency polygon is shown in Figure 1.

The mean number of ray flowers here is 11.365. The agreement with Lucas' Lot 4 is very close in all particulars except extent of range. This series gives peaks at the Fibonacci numbers 8 and 13, the principal one being at 13, as in his cases. In this series, as in Lucas' Lots 2, 3, 4, and 5, all the heads on each plant collected were counted. It would appear from a compari-

[1] Contributions from the Zoölogical Laboratory, University of Michigan. No. 90.

son of Lucas' Lot 1 with Lots 2 and 3 or 4 that this procedure tends to give a decidedly lower mean than is obtained from a random sampling of heads directly collected in the field.

A slight typographical error in the paper of Lucas to which

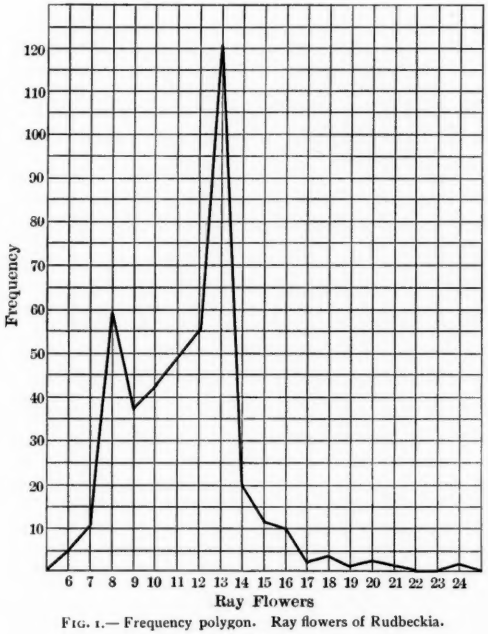

FIG. 1.— Frequency polygon. Ray flowers of Rudbeckia.

reference has been made, was noted. In the legend to Fig. 2 the number of heads in the combined Lots 2 and 3 is given as 468, while in the text Lot 2 is stated to have included 225 heads, and Lot 3, 240 heads.

NOTES AND LITERATURE.

ZOÖLOGY.

The Halictine Bees of America.— Mr. J. Vachal has published the descriptions of a large number of supposed new American bees of the genus Halictus, in the *Bulletin* de la Société Scientifique, Historique et Archéologique de la Corrèze (France), July–September, 1904. As this publication is one not usually seen by American naturalists, it will be useful to give a list of the species, with the localities and some indication of their characters. This information follows herewith in tabular form. I have not thought it worth while, at present, to give the characters of all the Mexican species; but the table clearly separates all those of the United States.

Abdomen with bands of pale hair or tomentum on the apical margins of the segments . . . . . 1.

Abdomen with bands or lateral patches of hair or tomentum at the bases of the segments . . . . . 4.

Abdomen without distinct bands or spots of pale hair or tomentum on the apical margins or at the bases of the segments, but often more or less covered with fine pubescence . . . . . 24.

1. Species without metallic tints . . . . . 2.
   At least the head or the thorax more or less metallic, with green tints . . . . . 3.
2. Very large, 14 mm. long (British Columbia) . . . *procerus*, ♂.
   Not over 11½ mm., allied to *H. parallelus* Say (Nevada) *denticulus* ♂, ♀.
3. Species of Georgia, New York, Pennsylvania, British Columbia, and Illinois; closely allied to *H. tumulorum* L. . *nearcticus*, ♀, ♂.
   Species of South America *ochromerus*, ♀ (Brazil) and *citricornis*, ♂, ♀ (Chili).
4. Abdominal segments black or brown, the margins concolorous . 5.
   Abdominal segments with the apical borders more or less testaceous or reddish . . . . . 9.
5. Posterior face of metathorax with a distinct, sharp border, at least at sides . . . . . 6.
   Posterior face of metathorax without such a border, the lateral margins rounded . . . . . 8.

6. Smaller, length not over 7 mm. (Mexico) . . . . *linctus* ♀.
   Larger, length 8 mm. or more; females . . . . . 7.
7. Species of Mexico . *trichecus*, *transversus*, *capitulatus*, and *æquatus*.
   Species of unknown origin, but closely allied to *H. pacificus* Ckll., with the size smaller; the enclosure of metathorax shorter, with finer striæ, etc. . . . . *citerior*.
8. Species of Mexico . *crocoturus*, *tricnicos*, *jubatus*, *circinatus*, *pharus*, *costalis*, *spinalis*, and *pallicornis*, the last based on a ♂.
   Species of British Columbia and Washington State; ♀ 10½ mm. long, black . . . . . *egregius*.
   Species of Colorado; ♂ 7½ mm. long, black, the apical half of the clypeus yellowish . . . . . *colatus*.
9. Posterior face of metathorax with a distinct sharp margin . . 10.
   Posterior face of metathorax with the lateral margins at least partly rounded . . . . . 22.
11. Females . . . . . 12.
    Males . . . . . 14.
12. Smaller, length less than 7 mm. (Mexico) . . *respersus* and *laneus*.
    Larger, length 7½ mm. . . . . 13.
    Largest, length 8–8½ mm.; black (South Carolina, New York, Georgia) . . . . . *crassus*.[1]
13. Abdominal bands at bases of segments 1 to 3 entire (Colorado) . . . . . *granosus*.
    Abdominal bands reduced, segments 2 and 3 having only small grayish spots on each side (Washington State) . . . . *occultus*.
14. Legs black (Mexico?) . . . . . *adelipus*.
    At least the tarsi partly yellow . . . . . 15.
15. Labrum black (California; a black species 8½ mm. long) *pullilabris*.
    Labrum yellow or testaceous . . . . . 16.
16. Mandibles black, at least basally, never yellow . . . . 17.
    Mandibles more or less spotted with yellow . . . . 19.
17. Anterior tibia without a yellow stripe; tubercles and tegulæ not spotted with yellow (Colorado) . . . . . *granosus*.
    Anterior tibia striped with yellow; tubercles and tegulæ with a yellow spot . . . . . 18.
18. Larger, length 9–9½ mm., face below the antennæ longer (British Columbia) . . . . . *arctous*.
    Smaller, length 7 mm.; face below the antennæ shorter (California) . . . . . *nigridens*.
19. Tubercles dark; face short, eyes converging below; basal area of metathorax almost semicircular, entirely occupied by irregular striolæ; length 7–7½ mm. (Colorado) . . . . *nigricollis*.

[1] *H. crassus* is said to differ from *H. similis* Sm., by its larger size, and the smoky yellow tint of the wings, and from *H. fulgidus* Crawf., by the color of the wings and the less punctured abdomen.

Tubercles, tegulæ, and anterior tibia more or less tinged or marked with yellow . . . . . 20.

20. Length 6 mm. or less; anterior tibia spotted with brown; sixth ventral segment of abdomen without an impression (California) . *gularis*.
Length 6½ mm. or more . . . . . 21.

21. Species of Mexico . . . . . *aratus*.
Species of Colorado; all the tibiæ yellow . . . *gelidus*.

22. Only the apical border of the abdominal segments pale . . 23.
Abdomen almost entirely reddish; 5 mm. long (Oaxaca, Mexico) . . . . . *curtulus*.

23. Species supposed to be Mexican; black, head small . *bivarus*, ♀.
Species of Colorado, Nevada, and Vancouver I.; about 6 mm. long, shining black; face long; mesothorax and scutellum finely, densely punctured; enclosure of metathorax lunate, with fine, irregular, indistinct striæ; wings bronzy-hyaline, nervures yellow; male with labrum dark, and legs brown, without yellow or testaceous markings . . . . . *diatretus* ♂, ♀.

24. Not metallic . . . . . 25.
At least the head or thorax more or less metallic . . . 26.

25. Posterior face of metathorax with a sharp border; black, head large; hind spur pale, with three sharp spines (Washington State) *fartus*, ♀.
Posterior face of metathorax with its lateral margins rounded, at least above; black, head small; length, ♀ 6½–7, ♂ 6 mm. (Mexico) *sertus*.

26. Species of South America
beskei (Brazil), *autranellus* (Buenos-Aires), *pisinnus* (Chile).
Species of unknown locality; ♂ 7 mm. long, green . *lanifer*.
Species of Mexico . . . . . 27.

27. Less than 7 mm. long . . . *cubitalis*, *sudus*, and *terginus*.
Over 7 mm. long . . . . *biseptus*, *ectypus*, and *coactilis*.

T. D. A. COCKERELL.

Notes on Recent Fish Literature.— Mr. C. Tate Regan, of the British Museum, continues his varied series of fish studies by a number of short papers in the *Annals and Magazine of Natural History*. One of these, "The Phylogeny of the Teleostomi" (May, 1904), must challenge the attention of all palæontologists by its bold theory that the chondrostean ganoids (Palæoniscum, Acipenser, Polyodon, etc.) are the most primitive of teleostomous fishes, and that they have given rise to the crossopterygians and dipnoans as well as to the ostracophores, arthrodires, and teleosts. After separating the still more primitive sharks, Mr. Regan divides the other fishes into five orders, Chondrostei, Crossopterygii, Placodermi, Dipneusti, and Teleostei. The Teleostei have sprung, in his scheme,

from the chondrostean ganoids, through the holostean ganoids (Aspidorhynchus, Lepisosteus, Amia, etc.) which he regards as teleosts. On the other hand, the Crossopterygii, likewise descended from Chondrostei, have given rise to Dipneusti (dipnoans) and also to Placodermi. This latter group includes both Ostracophores and Arthrodires. The Heterostraci are excluded from this group, being regarded as armored sharks.

The fact that palæontology does not bear out this view is dismissed with the statement that these conclusions "are in accordance with the morphological evidence, which is clearly and sufficiently complete, whilst the geological record is and must be from the nature of the case very incomplete."

The close resemblance between the basal structures of the paired and the unpaired fins in the Chinese Paddle-fish (*Psephurus gladius*) is one of the important pieces of evidence in favor of the primitive nature of the Chondrostei, and in favor of the origin of all fins alike from folds of skin.

The conclusions of Mr. Regan are thus summed up:

1. The Chondrostei are the most generalized Teleostomi.

2. The Crossopterygii differ from them in the lobate pectoral fin and in the larger paired gular plates.

3. The placoderms (Coccosteidæ, Asterolepidæ, Cephalaspidæ) are a natural group not related to the Heterostraci, which are Chondropterygii. They may probably be regarded as armored primitive Crossopterygii, this view being most in accordance with the arrangement of the cranial roof bones in Coccosteus, the structure of the ventral fin in Coccosteus, and the structure of the pectoral limb in Asterolepidæ (which structure he regards as a true pectoral fin).

4. The Dipneusti probably originated from more specialized Crossopterygii, *e. g.*, from the neighborhood of the Holoptychidæ.

5. The Teleostei differ in so many respects from the Chondrostei that they should rank as an order in which the Holostei are included.

This view of the case is original and suggestive, but so far as the major premise (No. 1 above) is concerned, most naturalists will find it unconvincing.

Mr. Regan discusses the genus Lichia of Cuvier, dividing it into two genera, Lichia (Amia) and Campogramma Regan (Vadigo). *Lichia glauca* he refers to the genus Trachinotus. The gaff-top-sail Pampano, also called *Trachinotus glaucus*, a name of later date, is deprived of its name by the intrusion into the same genus of an

earlier *glaucus*. To this American species Regan gives the new name of *Trachynotus palometa*. Porthmeus is a synonym of Lichia, while Hypodis Rafinesque, not mentioned by Regan, is a synonym of Trachinotus.

Regan re-describes *Holocentrus osculus* Poey, and describes *Centropomus argenteus*, a new species, allied to *C. ensiferus*, from Barbadoes and Guiana. *C. mexicanus* he regards as identical with *Centropomus parallelus*.

The following new species are also described by Mr. Regan: *Clupea* (*Opisthonema*) *bulleri* from Las Peñas in Jalisco; *Engraulis argentivittatus* from Las Peñas; *Pseudoxiphophorus pauciradiatus* from Orizaba; *Zoogoneticus maculatus* from Rio Santiago;[1] *Characodon geddesi* from Lake Tezcoco, Mexico; *Heros octofasciatus* from British Honduras; *Heros callolepis* from Santo Domingo de Guzman, Mexico; *Pristigaster* (*Opisthopterus*) *effulgens* from Ecuador; *Ophichthys* (*Pisodontophis*) *brevimanus* from Ecuador; *Piabucina astrigata* from Ecuador; *Piabucina pleurotænia* from Venezuela; *Trichomycterus vittatus* from Peru; *Trichomycterus retropinnis* from Colombia; *Trichomycterus meridæ* from Venezuela; *Pimelodus* (*Pimelodella*) *tæniophorus* from Matto Grosso; *Pimelodus* (*Pimelodella*) *griseus* from Ecuador; *Haplochilus peruanus* from Peru; *Belone* (a *Tylosurus*) *fluviatilis* from Ecuador; *Centropomus atridorsalis* from Ecuador; *Corvina* (a *Sciæna*) *crawfordi* from Montevideo; *Acara saparensis* from Ecuador; *Gobius* (*Awaous*) *guentheri* from Ecuador;[2] *Chasmodes maculipinna* from Ecuador; *Chætodon dixoni* from the New Hebrides; *Draconetta acanthopoma* from the deep waters of the North Atlantic.

Draconetta is considered by Mr. Regan, probably correctly, as an ally of Harpagifer. The nominal family of Draconettidæ is therefore not to be separated from the Harpagiferidæ, and is a close ally of the Nototheniidæ.

A considerable collection made at Rio Janeiro by Dr. Gœldi is the subject of an important paper. The following are the chief additions:

Raia cyclophora new species; *Muræna helena* a Mediterranean

[1] *Fundulus labialis* and *F. guatamalensis* are probably not species of Zoogeneticus as has been suggested by Dr. Meek.

[2] *Gobius latus* O'Shaughnessy is not identical with *G. flavus* nor with *G. banana*. *Gobius* or *Awaous banana*, the West Indian species, should not be identified with *Gobius* (*Awaous*) *taiasica*, a Brazilian species which is probably the same as *Awaous latus*.

species now recorded from Brazil; *Atherinichthys sallei* for a new species of Menidia from Mexico; *Serranus flaviventris* should include *S. dispilurus*, *S. subligarius*, and *S. brasilienis*. It is distinct from *S. auriga*. *Diagramma gœldii* is identical with *Genypterus cavifrons*, for which species Mr. Regan does not accept the older but somewhat doubtful name, *luteus*. *Mylacrodon gœldii* is a new genus allied to Pomadasis but with some molar-like teeth.

The Old World genera, Gazza and Leiognathus, are referred to the Gerridæ, from which they differ in the small scales and in having the gill membranes narrowly united to the isthmus. Regan gives an analysis of the striped species of true Gerres he regards as tenable, *viz.*, *brevimanus*, *plumieri*, *mexicanus*, *lineatus* (including *brasilianus* and *embryx* of the Atlantic coast), *axillaris*, and *patao*. *G. brasilianus* is, however, not the same as *G. lineatus*.

Pristedion altipinnis new species; *Oligoplites saliens* (with four dorsal spines) is a valid species, as are also *O. palometa*, *altus*, *saurus*, and *mundus*.

Not knowing the species of Spanish Mackerel, called *Scomberomorus regalis*, Regan identifies it with *S. maculatus*. The fishermen know better. *Scomberomorus immaculatus* from San Domingo is not identical with *S. cavalla*.

Genypterus brasiliensis, new species; *Achirus fonsecensis* is recorded for the first time from the Atlantic and *Lophius piscatorius* for the first time from Brazil.

In 1900, the "*Albatross*" made a short dredging cruise on the coast of Japan, taking 111 species of fishes. Of these, 58 were new to science and have been described by President Jordan and his associates. In a paper in the *Bulletin* of the United States Fish Commission for 1903, figures of all these new species are given, with references, notes, and descriptions of a number of new species. This memoir is by Jordan and Starks. With it is included a monographic review of the Macrouridæ, or Grenadier-fishes of Japan, by Jordan and Gilbert, with figures of most of the numerous species.

The most important faunal work in ichthyology for the year is the account of the Fishes of Panama Bay by Professor Charles H. Gilbert and Mr. Edwin C. Starks, published by the California Academy of Sciences (Mem., Vol. 4), and reprinted by the Hopkins Seaside Laboratory of Stanford University.

This paper contains a very full account of the fishes of Panama,

374 in all, with excellent plates, the work of Mrs. Chloe Lesley Starks, representing most of the new forms. The descriptions are prepared with that minute attention to accuracy characteristic of all of Dr. Gilbert's work. Of the many new species, the majority were included in the appendix to Jordan and Evermann's fishes of North America. Those not so included are the following:

Galeichthys eigenmanni, *Tachysurus evermanni*, *Fistularia corneta*, *Oligoplites refulgens*, *Peprilus snyderi*, *Sagenichthys* (properly *Macrodon*) *mordax*, *Pomacentrus gilli*, *Halichœres macgregori*, *Balistes verres*, *Xesurus hopkinsi*, *Guentheridia*, a new genus of Tetraodontidæ (*formosa*), *Prionotus ruscarius*, *Microgobius miraflorensis*, *Evermannia panamensis*, *Batrachoidea boulengeri*, *Porichthys greenei*, *Hypsoblennius piersoni*. *Lythrulon opalescens* is not distinguishable from *L. flaviguttatum*, and *Menticirrus simus* is identical with *M. nasus*. *Eleotris æquideus* cannot be separated from *E. pictus*, and *Microgobius cyclolepis* is the same as *M. emblematicus*. *Ancylopsetta sabanensis* is identical with *A. dendritica*, and the genus *Ramularia* is not tenable. *Solea fischeri* and *Solea panamensis* are synonyms of *Achirus fonsecensis*.

The following conclusion as to the relations of the fish faunas on the two sides of the isthmus of Panama is of special interest. "The ichthyological evidence is overwhelmingly in favor of the existence of a former open communication between the two oceans, which must have become closed at a period sufficiently remote from the present to have permitted the specific differentiation of a very large majority of the forms involved. That this differentiation progressed at widely varying rates in different instances becomes at once apparent. A small minority of the species remains wholly unchanged, so far as we have been able to determine that point. A large number have become distinguished from their representatives of the opposite coast by minute (but not 'trivial') differences, which are wholly constant. From such 'representative forms,' we pass by imperceptible gradation to species much more widely separated, whose immediate relation in the past we cannot confidently affirm. Of identical species, occurring in both oceans, our Panama list contains 43.

"The total number of identical species which we recognize in the two faunas now separated by the Isthmus is therefore 54, as compared with the 71 enumerated by Jordan (1885). It is obvious, however, that the striking resemblances between the two faunas are shown as well by slightly divergent as by identical species, and the evidence in favor of interoceanic connection is not weakened by an increase in

one list at the expense of the other. All evidence concurs in fixing the date of that connection at some time prior to the Pleistocene, probably in the early Miocene. When geological data shall be adequate definitely to determine that date, it will give us the best known measure of the rate of evolution in fishes.

Of the 82 families of fishes represented at Panama, all but 3 (Cerdalidæ, Cirrhitidæ and Nematistiidæ) occur also on the Atlantic side of Central America; while of the 218 genera of our Panama list, no fewer than 170 are common to both oceans. The well-developed families Centropomidæ and Dactyloscopidæ are peculiar to the tropical faunas now separated by the Isthmus of Panama."

In the *Journal* of the Academy of Natural Sciences at Philadelphia (Vol. 12), Mr. Henry W. Fowler has a valuable report on the fishes collected in Sumatra by Harrison and Heller; 248 species are embraced in this collection. This includes a number of new species. This paper contains notes on the little known forms, with excellent plates of many of them. The paper will be of great value in the study of the East Indian fauna. Several new subgenera are proposed. Deveximentum is a new genus allied to Leiognathus, based on *L. insidiator*; the same species is the type of the earlier name Equula.

In the *Proceedings* of the California Academy of Sciences, Vol. 3, series 3, the late Cloudsley Rutter records a few fishes from the Gulf of California. He unites the genus Villarius with Ictalurus and describes a new Eleotrid Goby under the name of *Pycnomma semisquamatum*. The genus is certainly close to the imperfectly known genus Gymneleotris. A new description of *Emblemaria oculocirris* is given.

In the same *Proceedings* Dr. Charles H. Gilbert has notes and descriptions of fishes of the Pacific. *Netuma mazatlana*, new species, from Mazatlan; *Nemichthys avocetta*, which is properly the same as *N. scolopaceus*;[1] *Schedophilus heathi*, new species, from Monterey; *Xeneretmus infraspinatus*, new species, from Cape Flattery. *Clevelandia rosæ* is identical with *Clevelandia ios; Rathbunella alleni*, new species, from Monterey; *Auchenopterus mexicanus*, new species, from La Paz.

[1] The supposed character of the dorsal rays in Nemichthys distinguishing it from other eels is fallacious, being produced by the drying of the specimen.

In the *Report* of the Illinois Fish Commission for 1902, Mr. Thomas Large gives a useful list of the fishes of Illinois, with analytical keys and notes on the different species.

In the *Proceedings* of the U. S. National Museum (Vol. 27) Jordan and Snyder describe new species of fishes from Hawaii as follows: *Brachysomophis henshawi*, *Ariomma lurida*, *Lactoria schlemmeri*, *Antennarius laysanius*, and *Apogon evermanni*. A number of other species are added to the fauna of the islands. Ariomma is a new genus, apparently allied to Apogon.

In the *Proceedings* of the Biological Society of Washington (Vol. 17) Dr. H. M. Smith describes a small eel found in the deep waters south of Nomans Land. It is entirely black and with the eyes wholly hidden. Otherwise it is quite similar to the common eel. Dr. Smith calls it *Anguilla cæca*.

In the *Proceedings* of the Scientific Society of Christiania for 1904, Dr. Collett describes four new species of deep-sea fishes from the Faroë Islands. These are *Etmopterus princeps*, *Pristiurus murinus*, *Chimæra mirabilis*, and *Halargyreus affinis*. The Chimæra is made the type of a new subgenus called Bathyalopex, having the anal united with the caudal. The Japanese species *mitsukurii* would belong to this group, which is, however, scarcely entitled to distinctive rank.

In the *Bulletin* of the Museum of Comparative Zoölogy at Harvard College (Vol. 46, No. 1) Dr. Eastman gives a very interesting account of the history of the fish collections from Monte Bolca in Tuscany. A fine collection of these fishes is now in the Museum of Comparative Zoölogy. Dr. Eastman gives the synonymy of the principal species in this collection, with descriptions and figures of the most important species. The new generic name Histionotophorus is proposed for a Lophioid form and a new species of Pygæus, *P. agassizi*, is described and figured. The species called *Symphodus szajnochæ* doubtless represents a new genus of Labridæ, and the so-called *Caranx primævus* should also represent a new genus even more Trachurus-like than Trachurus itself.

In the *American Journal of Science* (Vol. 18, No. 104), Dr. Eastman discusses the appendages of Asterolepis. He regards these paddles as not homologous with the pectoral fins of the true fishes, his view being opposed to that recently put forth by Mr. Regan.

In the *Journal* of the College of Science of Tokyo (Vol. 19) Dr. Bashford Dean gives an elaborate account of the anatomy of the long-snouted Chimæra of Japan, *Rhinochimæra pacifica*.

In the *Journal* of the College of Science at Tokyo, Dr. Bashford Dean discusses the hag-fishes, or Myxinoids, of Japan, describing a new genus, *Paramyxine atami*, and a new species, *Homea okinoseana*. He also adds notes on *Homea burgeri* and *Myxine garmani*, with an analysis of the species of the genus, which he calls Homea, but which must stand under the less satisfactory but earlier name of Eptatretus. In the same *Journal* Dr. Dean has notes on the Chimæras of Japan, giving a full account with excellent plates of *Chimæra mitsukurii* and *C. phantasma*. The distinction between these two species was recognized almost simultaneously by Jordan and Snyder, who adopted the name "*mitsukurii*" proposed by Dr. Dean in correspondence.

Dr. Léon Vaillant in the *Comptes Rendus* for 1904 gives an interesting account of the Japanese goblin shark, *Mitsukurina owstoni*, of which a specimen about seven feet long has been received by the Museum at Paris. Dr. Vaillant puts the species in the family of Lamnidæ with Odontaspis and other related forms.

In the *Bulletin* of the Museum at Paris for 1903, Dr. Vaillant gives an account of the hatching of eggs in the branchial cavity in the species of Apogon-like fish, called *Cheilodipterus affinis*, at Martinique.

In the same *Bulletin*, Dr. Vaillant and Dr. Pellegrin give new descriptions of the species of Tetragonopterus, very briefly and unrecognizably mentioned in 1868 by Dr. M. F. Bocourt in the *Bulletin* of the Société Zoölogique de France. Dr. Pellegrin also gives an account of fishes collected on the coast of Chile.

In the *Records* of the Australian Museum (Vol. 5, No. 4), Mr. Edgar R. Waite gives a valuable account of rare fishes lately taken on the coast of eastern Australia. He shows that the genus Goodella is the larval form of Trachinocephalus. The identity of the Japanese genus Iso with the Australian Tropidostethus is also indicated; but Mr. Waite overlooks the fact that the latter name is preoccupied, and the genus may still remain Iso.

In the *Zoologischer Anzeiger* (Vol. 27, No. 22), Dr. L. S. Berg describes a new genus of sturgeons which he calls Huso, the type being *Acipenser huso*. This differs from the other sturgeons in having the gill membranes united, forming a free fold across the isthmus. The snout is soft and flexible and the very large mouth includes the whole under surface of the snout. The barbels are compressed. This definition is a new one, but the generic name Huso was used by Brandt and Ratzeburg in 1883 for a subgenus including the same type.

Under the title of "Pescas do Annie," Dr. Alipio de Miranda Ribeiro gives an account of fishes taken by the Steamer "*Annie*" off the coast of Brazil with the "otter trawl." Fifty-nine species were obtained. These are illustrated by means of photographs. Among the new species are *Fistularia rubra*, *Anthias duplicidentatus*, *Liocsacus intermedius*, *Pontinus corallinus*, *Peristedion roseum*, *Pseudopercis numida*, *Hypsicometes heterurus*, *Lepophidium fluminense*, *Urophycis mystaceus*, *U. latus*, *Paralichthys triocellatus*, and *Gymnachirus zebrinus*.

In *Sports Afield* for August, 1904, Dr. Barton W. Evermann gives valuable suggestions as to how to study a lake. This has particular reference to training children and young students to learn how to weigh evidence. Dr. Evermann calls attention to the fact that most of the so-called "bottomless" lakes are from 40 to 60 feet deep.

In the *Bulletin* of the U. S. Fish Commission for 1904 Dr. Jordan gives an account of fishes collected by Dr. Joseph C. Thompson on the Tortugas, with the descriptions of several species, four of them new, *viz.*:— *Ctenogobius tortugæ*, *Gnatholepis thompsoni*, *Elacatinus oceanops*, and *Ericteis kalisheræ*. A new genus, Acteis, is proposed for the small blenny called *Malacoctenus moorei*.

Under the title of "The Fresh-water Fishes of Mexico north of the Isthmus of Tehuantepec," the Field Columbian Museum publishes a most valuable faunal monograph by Dr. Seth Eugene Meek. It represents the results of two expeditions to Mexico, together with the examination of all previous papers on the fish fauna of that region. Two hundred and twenty-seven species are described, 28 of them being new, with three new genera. Excellent plates of these species and many others are given, with a map of Mexico, and

a very illuminating discussion of the faunal regions into which Mexico is divided.

The new genera are Cynodonichthys, allied to Fundulus, but with large canines, Paragambusia, and Thorichthys, the latter related to Cichlasoma. Dr. Meek recognizes four distinct fish faunas in Mexico. One of these in the northeast is composed largely of migrants from the north, as Carpiodes, Ictalurus, Lepisosteus. Another is made up of migrants from the south, as Rhamdia, Cichlasoma, etc. The third region includes the valley of the Rio Grande de Santiago, including the now isolated lakes about the city of Mexico. This includes most of the characteristic Mexican types as Chirostoma, Goodea, Aztecula, Evarra, etc. Very many species in this region are viviparous. The genus Chirostoma stands out as almost the only case among fishes where numerous closely related species inhabit exactly the same waters. In the large lake of Chapala, there are eight closely allied representatives of this type, all taken in the same nets, and all alike known in the markets as the "Pescado blanco," noted for its delicate flavor. These species are *Chirostoma chapalæ*, *grandocule*, *promelas*, *sphyræna*, *lucius*, *lermæ*, *ocotlanæ*, and *estor*. In several other lakes, other species occur in similar assemblages. But one species of Chirostoma is known outside the Lerma-Santiago fauna. In almost every other case among fishes, where two closely related species occur, they are not in the same waters, but in neighboring waters. This indicates that almost all species of fishes have originated through geographical isolation. Possibly the forms of Chirostoma may have come into existence as mutations or saltations. In no other case in ichthyology is this theory equally plausible. The fourth faunal basin of Mexico includes the large river Balsas, flowing southward, and containing but few kinds of fishes. The most notable is a very large cat-fish peculiar to this basin, constituting the genus Istlarius.

In the *Bulletin* of the Illinois State Laboratory of Natural History (March, 1904), Mr. R. E. Richardson gives a monographic review of the sun-fishes (Lepomis and Eupomotis) found in Illinois. He places *euryorus* in the genus Lepomis, and recognizes two species (*gibbosus* and *heros*) under Eupomotis. Apomotis Mr. Richardson unites with Lepomis.

Otaki and Fujita have published two more folios of their "Fishes of Japan," (Tokyo, 1904,) with Japanese text, and large colored plates well executed, but of a size inconvenient for binding.

In the *Report* of the Government Biologist of the Cape of Good Hope for 1903, Dr. J. D. F. Gilchrist describes seventeen new species of fishes from that region. One new genus, Cyttosoma, allied to Cyttus, is also recorded.

In Vol. II of the *Results of the Danish Ingolf Expedition*, Dr. Adolf Severin Jensen gives an elaborate account of the Lycodinæ of North Europe and Greenland, with a series of excellent plates. The genus Lycodalepis is united by Jensen with Lycodes. The species generally receive better definitions than have been given by any previous author.

Dr. Gill discusses in the *Proceedings* of the United States National Museum for 1904 the relations of the family of Ammodytidæ. In view of the discovery of the Ammodytoid genus Embolichthys, with jugular ventrals, these fins being wanting in all previously known species, the group belongs among the jugular fishes. Dr. Gill finds no relative nearer than the Hemerocoetidæ.

In the *Biological Bulletin* for October, 1904, Mr. Edwin C. Starks discusses the osteology of the fishes of the order or suborder Haplomi. He finds it a heterogeneous group, including probably varying lines of descent, having the bond of union of abdominal ventral fins, no fin spines, and the loss of the mesocoracoid and orbitosphenoid characteristic of more primitive fishes.

In the *Revista Chilena de Historia Natural*, for 1904, Dr. Carlos E. Porter describes some new fishes from the deep seas of Chile.

In the *Transactions* of the Zoölogical Society of London, for 1904, Mr. C. Tate Regan gives a voluminous and important monograph of the mailed cat-fishes of the South American fauna known as Loricariidæ.

Dr. Joseph Schmitt publishes in Paris a valuable *Monographie de l'Ile Anticosti*, with a list of its animals, about 25 common fishes being included.

Jordan and Snyder describe in the *Proceedings* of the U. S. National Museum for 1904, *Apogon evermanni*, a new fish from Hawaii.

D. S. J.

BOTANY.

Silviculture.[1]—Silviculturists and others interested in forest management will welcome the second part of Professor Mouillefert's comprehensive treatise which is now out. The first part having considered in much detail from the forester's point of view the most important tree species, this second part deals especially with the management and exploitation of trees in assemblages or forests. After defining precisely the terms used, the author considers most comprehensively the principal methods of developing and harvesting the two forms of wood, high forest and coppice, and the application of these methods to the principal species of trees; gives advice as to what to seek in any given case, and describes the nature and amount of the product to be obtained, giving volume curves, directions for developing a forest working plan, calculations of annual revenue, and so on. Special chapters deal with the cultivation of osiers for the draining of soils and with the culture of truffles. The chief modes of cropping and marketing forest products are also taken up.

While special parts, such as rules for forest management and the tables of annual returns, are based upon conditions different from our own (it being possible by reason of the centuries of forestry practice in France to lay down rules of practice and estimate yields much more definitely than with us) nevertheless the general aspects of the subject, the principles of the science and art of silviculture are set forth so clearly and simply that the book is bound to be of general interest to foresters and students of forestry in this country. It will be particularly helpful in making clear to many certain sides of the subject, such as the mathematics of forest measurements, which, as they are often set forth in works on forestry, are not likely to be easily understood.

C. S. S.

Notes. — Loeb's St. Louis address on the recent development of biology is printed in *Science* of December 9th.

An important addition to the rather abundant recent literature of apogamy is made by Strasburger, in a study of Alchemilla published in the opening number of Vol. 41 of the *Jahrbücher für wissenschaftliche Botanik.*

[1] Mouillefert, P. *Traité de Sylviculture* — Part 2 — *Exploitation et Aménagement des Bois.* Paris, Alcan. 1904. 12mo, 476 pp., 10 pls. 97 figs.

An account of the "blaze-currents" of vegetable tissues, by Waller, forms part of Vol. 37, No. 257, of the *Journal* of the Linnean Society, Botany.

A paper on the absorption of electro-magnetic waves by living vegetable organisms, by Squier, has been reprinted from General MacArthur's *Report* to the War Department on the Military Manœuvres in the Pacific Division, 1904.

A considerable discussion of the use of copper for the treatment of polluted drinking water is contained in the *American Journal of Pharmacy* for December.

The "summer-fall" of the leaves of Canary Island plants forms the subject of a note by Vahl in Heft 2 of the *Botanisk Tidsskrift* for 1904.

An interesting study of sandal seedlings is published by Barber in *The Indian Forester* for December.

Papers on myrmecophilous plants by Morteo and Villani are contained in Vol. 18, Fascicle 10–12 of *Malpighia*.

Methods of surveying vegetation on a large scale are discussed with illustrative diagrams, by Oliver and Tansley in *The New Phytologist* of December 20.

Certain traumatic floral anomalies, and their heredity, are discussed by Blaringhem in the *Bulletin* of the Muséum d'Histoire Naturelle of Paris, 1904, No. 6.

A paper on the structure of the starch grain, by Denniston, has been separately issued from Vol. 14 of the *Transactions* of the Wisconsin Academy of Sciences.

An anatomical study of *Anemiopsis californica* is published by Holm in *The American Journal of Science* for January.

A paper by Drabble on the anatomy of the roots of palms forms Vol. 6, Part 10, of the current botanical series of *Transactions* of the Linnean Society of London.

An interesting presentation of some of Burbank's experiments is given by Jordan in *Popular Science Monthly* for January.

A progress report on the strength of structural timber, by Hatt, forms *Circular No. 32* of the Bureau of Forestry, U. S. Department of Agriculture.

A further study of the "popping" of Indian corn, by Professor Storer, is contained in Vol. 3, Part 4 of the *Bulletin* of the Bussey Institution.

Heckel publishes a paper on *Solanum commersoni* and its variations as bearing on the origin of the cultivated potato in the *Revue Horticole* of Marseilles for November.

The banana in Hawaii forms the subject of *Bulletin No. 7* of the Hawaii Agricultural Experiment Station, by Higgins.

Bulletin No. 88 of the Bureau of Chemistry, U. S. Department of Agriculture, is devoted to the chemical composition of apples and cider.

A paper on California olive oil, by Shaw, forms *Bulletin No. 158* of the Agricultural Experiment Station of that State.

Some nature-photograms of cross-sections of wood are published by Russell in the *Gardeners' Chronicle* of November 26.

An ecological study of Brush Lake, by Schaffner, Jennings, and Tyler, forms Vol. 4, Part 4, of the *Proceedings* of the Ohio State Academy of Science.

A "Pugillus Cryptogamarum Canadensium," by Cufino, is published in *Malpighia*, Vol. 18, Fascicle 10–12.

Under the title "Bouquet de Fleurs de Chine," Léveillé publishes a number of new Chinese species in Vol. 39, Fascicle 4, of the *Bulletin* de la Société d'Agriculture, Sciences et Arts de la Sarthe.

A second paper on new or noteworthy Philippine plants, by Merrill, forms [*Bulletin*] *No. 17* of the Bureau of Government Laboratories of the islands, dated October 1, 1904.

Part 10 of Koorders and Valeton's "Additamenta ad Cognitionem Floræ arboreæ Javanicæ" forms No. 68 of the *Mededeelingen nit 's Lands Plantentuin.*

The flora of western Australia is receiving important treatment by Diels and Pritzel in current numbers of Engler's *Botanische Jahrbücher.*

Vol. 4 of the "Flora of Tropical Africa," edited by Sir William T. Thiselton-Dyer, has recently been completed.

Several additional species of Eschscholtzia are described by Fedde in No. 35 of the *Notizblatt* of the Berlin Garden.

A number of new species of cacti are described from the notes of the late Dr. Weber, by Gosselin, in No. 6 of the *Bulletin* of the Muséum d'Histoire Naturelle of Paris for 1904.

An attractive book, "Abbildungen der in Deutschland und den angrenzenden Gebieten vorkommenden Grundformen der Orchideen-Arten," by Müller, with descriptive text by Kränzlin, has been issued by R. Friedländer & Sohn, of Berlin.

Some interesting test-tube cultures of orchids are detailed by Bernard in the *Revue Générale de Botanique* of Nov. 15.

A revision of Tradescantia, as known from Texas, is published by Bush in Vol. 14, No. 7, of the *Transactions* of the Academy of Science of St. Louis.

The prothallium of *Ophioglossum vulgatum* is described by Bruckmann in the *Botanische Zeitung* of December 15.

Regnellidium diphyllum, the type of a new genus of Marsiliaceæ, from Brazil, is described and figured by Lindman in Vol. 3 of *Arkiv för Botanik.*

An important paper on Cyanophyceæ, by Zacharias, is separately printed from Vol. 21 of the *Jahrbuch der Hamburgischen wissenschaftlichen Anstalten.*

The first part of a historical review of the origin of species by mutation is contributed by Harris to *The Monist* of October.

An important paper by Goebel on cleistogamous flowers and the adaptation theories is begun in the *Biologisches Centralblatt* of November.

The summer activity of some spring flowers is discussed by Dr. Keller in Part 2 of the current volume of *Proceedings* of the Academy of Natural Sciences of Philadelphia.

A paper on the origin and nature of color in plants, by Kraemer, is contained in the *Proceedings* of the American Philosophical Society, No. 177.

Country Life in America for December contains striking pictures of *Anemone patens nuttalliana* blooming in the snow.

A lecture by Haberlandt on the sense organs of plants is being published in current numbers of the *Naturwissenschaftliche Rundschau.*

A treatise on the transpiration of plants, by Burgerstein, has recently been issued from the press of Gustav Fischer of Jena.

Bower's St. Louis address, dealing with the relation of the axis to the leaf in vascular plants, is printed in *Science* of October 21.

Coulter's St. Louis address on the development of morphological conceptions is printed in *Science* of November 11th.

A paper on cytological technique, by Osterhaut, forms Vol. 2, No. 11 of the botanical series of *University of California Publications.*

The comparative age of the different floristic elements of eastern North America is discussed by Harshberger in a separate from the August *Proceedings* of the Academy of Natural Sciences of Philadelphia.

Westgate gives an account of the reclamation of the Cape Cod sand dunes in *Bulletin No. 65* of the Bureau of Plant Industry of the U. S. Department of Agriculture.

Certain plants of the north temperate zone are contrasted with their representatives in the high mountains of tropical Africa by Engler in the *Annals of Botany* for October.

The second section of Volume 4 of the "Flora Capensis," covering Hydrophyllaceæ to Pedalineæ, has recently been completed, with index, under the editorship of the Director of the Kew Gardens.

An interesting paper on the forest flora of the Jubbulpore district of India is published by Hole in *The Indian Forester* of November.

The botanical zones of the Madeiras are discussed by Menezes in Vol. 8 of the *Annaes de Sciencias Naturaes* of Oporto.

An account of *Liquidambar styraciflua* is contributed to Nos. 8 and 9 of the current volume of *Anales del Museo Nacional de México*, by Alcocer.

De Vries' *Trifolium pratense quinquefolium* is discussed by Tammes in the *Botanische Zeitung*, Abt. 1, of November 15.

An account of the group of peaches known as honey-peaches is given by Reimer in *Bulletin No. 73* of the Florida Agricultural Experiment Station.

An illustrated monograph of the willows of France, with classification of the other European species, by A. and E. G. Camus, has been published from the office of the *Journal de Botanique*, of Paris.

Urbina gives an account of *Pedilanthus aphyllus* in the *Boletin del Museo Nacional de México* of March last.

In the *Gardeners' Chronicle* of Nov. 5 is given, by Müller, the first partial description of some of Sprenger's hybrid Yuccas.

An account of the tight-chaffed wheats, "emmer" and "spelt," by Saunders, forms *Bulletin No. 45* of the Central Experimental Farm, of Ottawa, Canada.

A neatly illustrated handbook of "New England Ferns and their Common Allies," by Helen Eastman, has been issued from The Riverside Press of Cambridge.

315 Pteridophytes, of which a number are new, are noted for Isthmian America by Hieronymus in Engler's *Botanische Jahrbücher* of October 25.

A monograph of North American Ustilagineæ, by Clinton, forming No. 57 of the "Contributions from the Cryptogamic Laboratory of Harvard University," is published as Vol. 31, No. 9, of the *Proceedings* of the Boston Society of Natural History.

Arsenic in papers and fabrics, and the so-called arseno-molds belonging to the genera Aspergillus, Penicillium, and Mucor, are discussed by Haywood and Warren in *Bulletin No. 86* of the Bureau of Chemistry, U. S. Department of Agriculture.

Sydow's "Monographia Uredinearum," in fascicle 5 reaches the end of Puccinia, of which 1231 species are recognized. The contents of the volume are rendered accessible by good indexes.

A paper on Mexican Uredineæ, by Holway, is contained in *Annales Mycologici* for September.

Colletotrichum glœosporioides, and its attacks on the pomelo, form the subject of *Bulletin No. 74* of the Florida Agricultural Experimental Station, by Hume.

Papers on Middleton Fungi — by Gates, and Fungi of Nova Scotia, a provisional list — by MacKay, have been separately issued from the *Proceedings and Transactions* of the Novia Scotian Institute of Science, Vol. 11.

Petri discusses the diagnostic value of the capillitium of Tylostoma in *Annales Mycologici* for September.

A third edition of Frost's "Laboratory Guide in Elementary

Bacteriology" has been issued from the Macmillan press, and gives a most serviceable foundation for a year's work.

An interesting article on invisible micro-organisms, by Dorset, is reprinted from the *Twentieth Annual Report* of the Bureau of Animal Industry, U. S. Department of Agriculture.

Volume 1 of Ward's "Trees: a Handbook of Forest Botany for the Woodlands and the Laboratory" (Cambridge, the University Press, 1904) deals with buds and twigs, and constitutes one of the best of the winter manuals yet published. In the second part of the volume, keys, figures, and descriptions facilitate the determination of British species.

An annotated account of trees and shrubs tested in Manitoba and the Northwest Territories, by Saunders, forms *Bulletin No. 47* of the Central Experimental Farm, at Ottawa, Canada.

In *Nature* of November 24, Mr. H. Charlton Bastian has again taken up the question of heterogenesis.

A contribution to the study of fermentation, by Twight and Ash forms *Bulletin No. 159* of the Agricultural Experiment Station of California.

An elaborate monograph of Hungarian Gasteromycetes, by Hollós, has been issued in German translation from the Weigel Press of Leipzig.

A characteristic colored plate of *Amanita muscaria* is given in *The American Botanist* of October.

A good "fairy-ring," apparently of *Agaricus arvensis*, is figured in *The American Inventor* of January 1, 1905.

Bulletin No. 75 of the Florida Agricultural Experiment Station is devoted to a discussion of potato diseases, by Hume.

A new catalogue of the plants cultivated in the botanical garden at Buitenzorg, by Hochreutiner, is begun in *Bulletin de l'Institut Botanique de Buitenzorg*, No. 19.

An account of the cultivation of *Papaver somniferum*, and the production of opium, in the United States is given by Richtmann in the *Pharmaceutical Review* of November.

A study of the chemical composition of some tropical fruits and their products, by Chace, Tolman, and Munson, forms *Bulletin No. 87* of the Bureau of Chemistry, U. S. Department of Agriculture.

A popular account of Christmas fruits and their sources is published by McFarland in *Country Life in America* for December.

Southern evergreens and their commercial utilization are discussed by Caldwell in *Country Life in America* for December.

Dr. Sherman's bulletin on Gutta Percha and Rubber of the Philippine Islands is being reprinted in *The Far Eastern Review*, of Manila, beginning with the issue of September.

According to No. 5 of the current volume of the *Bulletin du Jardin Impérial Botanique de St. Pétersbourg*, the living collections of plants at that institution in 1903 numbered 34,887 species and varieties, of which 27,516 required the shelter of plant houses.

An account of Bauhin's herbarium, with determinations by A. P. de Candolle, is published by Casimir de Candolle in Vol. 4, No. 3, of the *Bulletin de l'Herbier Boissier*.

M. Correvon, of Geneva, has recently issued an account of the first Congress of Alpine Gardens, held at the Rochers de Naye in August.

The Journals. — *Botanical Gazette*, November: — Jeffrey, "A Fossil Sequoia from the Sierra Nevada"; Shull, "Place-Constants for *Aster prenanthoides*"; Robinson, "A New Sheep-poison from Mexico"; Nelson, "Some Western Species of Agropyron"; MacMillan, "Note on some British Columbian Dwarf Trees"; Jeffrey and Chamberlain, "Celloidin Mechanique"; and Life, "An Abnormal Ambrosia."

The Bryologist, November: — Fink, "Further Notes on Cladonias — IV"; Grout, "Hepatics with Hand Lens."

Bulletin of the Torrey Botanical Club, October: — Bessey, "The Chimney-shaped Stomata of *Holacantha Emoryi*"; Kellicott, "The Daily Periodicity of Cell-division and of Elongation in the Root of Allium"; Emerson, "Relationship of Macrophoma and Diplodia"; Rydberg, "Studies on the Rocky Mountain Flora — XII."

Bulletin of the Torrey Botanical Club, November: — Cushman, "Desmids from Newfoundland"; Horne, "An Anomalous Structure on the Leaf of a Bean Seedling"; House, "The Nomenclature of *Calonyction bona-nox*"; Murrill, "The Polyporaceæ of North America — IX"; Britton, "On *Pisonia obtusata* and its Allies."

Journal of the New York Botanical Garden, November: — Britton, "Report on Exploration of the Bahamas."

Vol. 1 of the *Memoirs* of the Horticultural Society of New York, issued late in 1904, is devoted to the important Proceedings of the International Conference on Plant Breeding and Hybridization held in New York City in October, 1902.

Part 3 of the third series of *Minnesota Botanical Studies* contains the following articles: — Lyon, "The Embryogeny of Ginkgo"; Leavitt, "Observations on *Callymenia phyllophora*"; Warner, "Observations on *Endocladia muricata*"; Mueller, "Observations on *Laminaria bullata*"; Howe, "Minnesota Helvellineæ"; Polley, "Observations on *Physalacria inflata*"; and Freeman, "Symbiosis in the genus Solium."

The Ohio Naturalist, November: — Kellerman and Gleason, "Notes on the Ohio Ferns"; Schaffner, "Leaf Expansion of Trees and Shrubs in 1904"; Gleason, "A New Sunflower from Illinois"; Schaffner, "Twigs of the Common Hackberry," and "Six Mutating Plants."

The Plant World, October: — Safford, "Extracts from the Note-Book of a Naturalist on the Island of Guam — XXIII"; Barrus, "Pussy Willows"; Barrett, "Tanier, the Oldest Crop"; Atwell, "Propagation by Petiole Buds"; Schneck, "Hybridization in the Honey Locust."

Rhodora, October: — Fernald, "The American Representatives of *Pyrola rotundifolia*"; Hoffmann, "Notes on the Flora of Berkshire County, Mass."; Knowlton, "Notes on the Flora of Day Mountain, Franklin Co., Me."; G. E. D., "The Death of William Wendte"; Waters, "*Asplenium ebeneum proliferum*"; Day, "*Juncus effusus compactus* in N. H."; Chamberlain, "*Plantago elongata* in Mass."

Torreya, October: — Underwood, "The Early Writers on Ferns and their Collections — III"; Murrill, "A New Species of Polyporus from Tennessee"; Britton, "The Florida Royal Palm"; Berry, "Otto Kuntze on Sequoia."

Torreya, November: — Harper, "Two Hitherto Confused Species of Ludwigia"; Murrill, "A Key to the Perennial Polyporaceæ of Temperate North America"; Gleason, "Additional Notes on Southern Illinois Plants"; Cockerell, "*Hymenoxys insignis*"; Britton, "*Rhynchospora Pringlei*"; Shafer, "Notes on Cuban Plants"; Grant, "A Peculiar Pea Seedling"; Millspaugh, "A New Bahaman Euphorbia"; E. G. Britton, "The Effect of Illuminating Gas on Trees and

Shrubs"; Greene, "A Name explained [Xolisma or Cholisma]"; Howe, Exogenous Origin of Antheridia in Anthoceros."

Vol. 2, No. 3, of *Contributions from the Botanical Laboratory of the University of Pennsylvania* contains the following articles: — Phillips, "A Comparative Study of the Cytology and Movements of the Cyanophyceæ"; Watson, "Structure and Relation of the Plastid"; Harshberger, "The Relation of Ice Storms to Trees"; Conrad, "Phyllody in Nelumbo"; Cooke and Schively, "Observations on the Structure and Development of *Epiphegus virginiana*"; Boewig, "Histology and Development of *Cassytha filiformis*"; Farr, "Notes on some Interesting British Columbian Plants"; Macfarlane, "The History, Structure and Distribution of *Sarracenia Catesbæi*"; and an announcement of three phanerogamic monographs shortly to be published.

Vol. 2, Part 2, of the *Annals of the Royal Botanic Gardens, Peredeniya* contains a second part, well illustrated, of Wright's "The Genus Diospyros in Ceylon," a paper by Lock "On the Growth of Giant Bamboos," one by Svedelius "On the Life-History of *Enalus acoroides*," and the first of "Studies in Plant Breeding in the Tropics," by Lock.

Botanical Gazette, December: — Copeland, "The Variation of some California Plants"; Newcombe, "Klinostats and Centrifuges for Physiological Research"; Cooley, "Ecological Notes on the Trees of the Botanical Garden at Naples"; Bergen, "Relative Transpiration of Old and New Leaves of the Myrtus Type"; Coulter and Chrysler, "Regeneration in Zamia"; and Parish, "New or Unreported Plants from Southern California."

The Bryologist, January: — Smith, "William Starling Sullivant, with Portrait"; Grout, "Spore Distribution in Buxbaumia"; E. G. Britton, "Notes on Nomenclature.— IV, The Genus Neckera."

The Fern Bulletin, October: — Fitzpatrick, "The Fern Flora of Montana"; Maxon, "Notes on American Ferns — VII"; Dukes, "Fall Fruiting of Osmunda"; Foster, "The Broad Wood Fern in Washington"; Dukes, "Babyhood of Ferns"; Woolson, "*Nephrodium pittsfordensis*"; Fitzpatrick, "Notes on the Ferns of Washington"; Cocks, "Notes from Louisiana"; Clute, "The Jamaica Walking Fern"; Eaton, "*Pellæa ornithopus*"; Hahne, "Forking Ferns"; Phelps, "New Stations for two rare Connecticut Ferns"; Schneck, "*Asplenium Ruta-muraria* on the Towers of Milan Cathedral"; and Clute, "*Adiantum Capillus-Veneris* in Pennsylvania."

The Plant World, November: — Safford, "Extracts from the Note-Book of a Naturalist on the Island of Guam —XXIV"; W. W. Bailey, "River Botanizing"; Wetzstein, "The White Prickly Poppy in Northwestern Ohio."

Rhodora, November: — Brainerd, "Hybridism in the Genus Viola"; Blanchard, "A New Species of Blackberry"; House, "A New Violet from New England"; Clark, "*Dalibarda repens* near Boston"; Ward, "*Mimulus moschatus* in Mass."; and Holt, "Subularia at East Andover, N. H."

Torreya, December: — Shafer, "The American Sennas"; Richards, "A Case of Irregular Secondary Thickening"; Sumstine, "The Boletaceæ of Pennsylvania"; Berry, "Recent Contributions to our Knowledge of Paleozoic Seed-Plants"; Wilson, "Some Introduced Plants in Cuba."

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